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FINAL REPORT

MULTI-INTEGRATOR DELTA MODEM

CONTRACT NAS 9-11901

DECEMBER 10, 1971

PREPARED FOR: NASA
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

RCA
GOVERNMENT COMMUNICATIONS SYSTEMS
CAMDEN, NEW JERSEY

FINAL REPORT

A series of monthly reports have been submitted, which outlined the progress on the design and construction of the delta modem as it occurred. In addition, a test plan and a test report was submitted, to delineate the way in which the equipment would be evaluated and the results thereof. Since the units have been delivered and accepted by NASA, following their own synchronization and subjective listening tests, this final report consists of a compilation of last minute improvements and test results, not covered in prior reports.

The LPF preceding the VOGAD preamplifier on the M1 board was tested in regard to its rejection of possible timing noise resulting from operating at the lowest standard rate of 9.6 KHz. The filter was found to attenuate this frequency 47.5 dB, which is satisfactory and in agreement with the test results submitted in November indicating an attenuation figure in excess of 45 dB.

The dynamic range of the VOGAD preamplifier, also on board M1 was extended to a full 30 dB while introducing a distortion of less than 5% into the audio signal being processed. This was accomplished by adding two fixed resistors across the FET's used as the gain controlling impedances in the AGC loop. These fixed resistors limited the control range of the FET drain impedance, which was found to become very non-linear with respect to the applied gate voltage, as the devices neared cutoff.

The test report listed the six companding levels in the modulator and the demodulation as being set at ± 1, ± 3 and ± 5 units. These companding levels were reset during the final listening tests to ± 1, ± 2, and ± 3 units, by changing four resistors on the M4/D4 boards.

The signal integrators, originally set with a time constant of about 100 Hz, were re-evaluated and the time constant was changed to 3.21 KHz. Since the signal integrators handle only sampled data, or in the case of the delta-sigma connection sampled data mixed with incoming audio information, the time constant must be chosen to be large in respect to the longest standard timing interval, obtained during 9.6 Kbps operation. On the final listening tests, the RC time constant was set at a value found most satisfactory in a prior RCA speech processor development.

An evaluation of the synchronization characteristics, in respect to the theoretical Becker and Lawton criterion for coherent PSK, was conducted at all standard timing rates from 9.6 to 76.8 Kbps. The test results, that is the E_b/N_o versus the BER, was tabulated and delivered to NASA with the equipment. Since these tests were repeated satisfactorily by NASA at their own facility, the RCA figures are of academic interest only.

The LPF on the demodulator output D1 board was changed from a fourth order to a sixth order Chebychev filter, with its 3 dB cutoff point set at 3 KHz. The new filter was much superior to the previous one, in its ability to reject the undesired 4.8 KHz resulting from a "1010" idling

pattern, while operating at the lowest standard timing rate of 9.6 Kbps. The sixth order filter response was measured, and found to attenuate 4.8 KHz by 37.2 dB and 9.6 KHz by 54 dB.

This final report completes the technical performance proposed and contracted by RCA with NASA.